Small Business Innovation Research/Small Business Tech Transfer

Smart Fault Management (SFM), Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

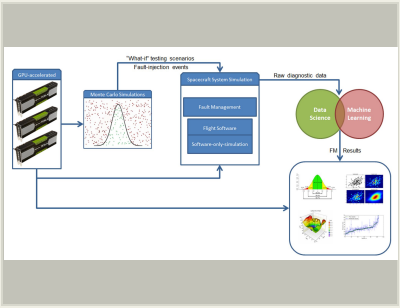
The Phase I of the SBIR "Smart Fault Management" project aims to demonstrate how the fault management process can be innovated by exploiting concepts from a combination of well-established and emerging disciplines such as Bayesian Statistics, GPU-accelerated numerical simulations, Data Science, and Machine Learning that are disrupting the current status quo in many scientific and engineering fields. Each of these disciplines provides well-established, cutting-edge tools that accurately combined and fine-tuned for the Fault Management arena will reshape the current FM architecture paradigm.

TMC will develop a proof-of-concept SFM system under the inputs and guidance of the NASA Center leading the effort. A representative spacecraft simulator will be identified in order to serve as the ground-truth model and data source. Test scenarios focusing on randomized fault injection will be developed and exercised against the software-only-simulation. The Monte Carlo simulation will be converted into a GPU-accelerated scientific application by exploiting massively parallel computing techniques enabled by the Compute Unified Device Architecture (CUDA) general purpose parallel computing architecture of modern NVIDIA GPUs. The large amount of raw diagnostic data, produced by the simulations system bundle (software-only-simulations plus Monte Carlo simulations), will be reduced, analyzed, visualized and modelled using big data mining techniques – a combination of data science concepts and machine learning algorithms – to thoroughly explore the higher-dimensional output space. The results will grant unbiased and unique access to the most influential variable trends, individual design parameters, and specific combinations of parameters that play a critical role in system failures and in the overall fault management behavior of a spacecraft system.

Anticipated Benefits

The technologies described in this SBIR Phase I proposal are currently being applied in various NASA projects, including dynamic testing, V&V, and mission training. The core technologies proposed in this SBIR are also applicable to spacecraft and unmanned (aircraft) system test beds. One of the main advantages of SFM is that the Data Science and Machine Learning component of the project can be utilized as a stand-alone application to investigate other NASA data-intensive research areas.

This SBIR Phase I proposal is applicable to non-NASA applications that focus on risk and fault management. For example, FAA and commercial drones can benefit from Monte Carlo and Machine Learning computing techniques. These techniques allow for accurate V&V characterization of systems failure potential, range safety software reliability, fault tolerance, flight software assurance, and software requirements clarification by automatically generating "what-if" scenarios for advanced V&V analysis.



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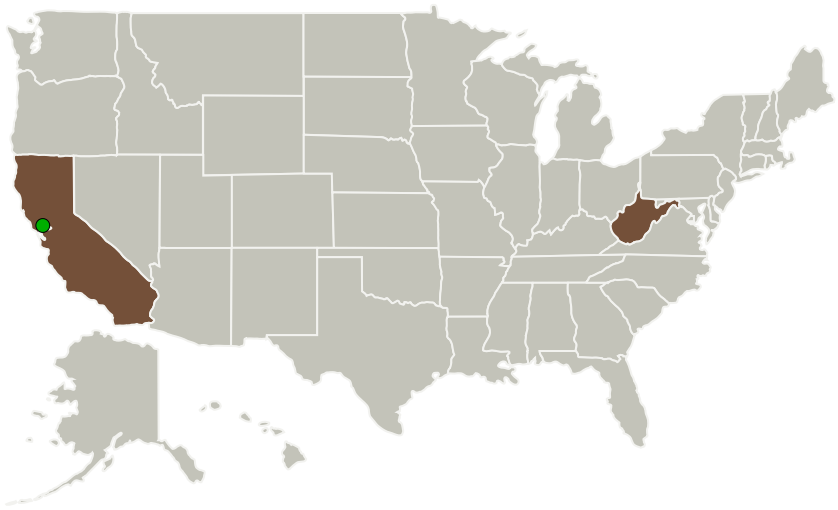
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
TMC Technologies of WV Corporation	Lead Organization	Industry Historically Underutilized Business Zones (HUBZones)	Fairmont, West Virginia
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations	
California	West Virginia

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

TMC Technologies of WV Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

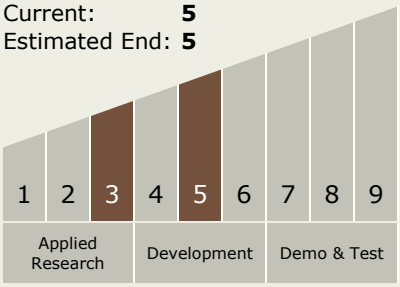
Carlos Torrez

Principal Investigator:

Max Spolaor

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



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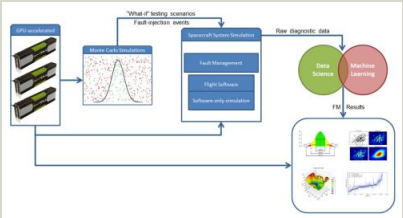
February 2019: Closed out

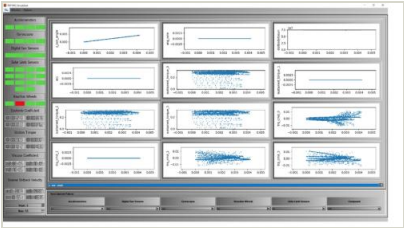
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137906)*

Images



Briefing Chart Image
Smart Fault Management (SFM), Phase I
(https://techport.nasa.gov/image/130430)



Final Summary Chart Image
Smart Fault Management (SFM), Phase I
(https://techport.nasa.gov/image/126531)

Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.6 Ground Computing
    - TX11.6.4 Quantum Computer

Target Destinations

Earth, Foundational Knowledge